3864

OTS: 60-31,748

JPRS: 3864

14 September 1960

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THE POLISH LONG-RANGE PLAN (1961-1975) AND FIVE-YEAR PLAN (1961-1965) FOR SCIENTIFIC RESEARCH IN AGRICULTURAL TECHNOLOGY

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Distributed by:

OFFICE OF TECHNICAL SERVICES
U. S. DEPARTMENT OF COMMERCE
WASHINGTON 25, D. C.
Price $0.75

U. S. JOINT PUBLICATIONS RESEARCH SERVICE
205 EAST 42nd STREET, SUITE 300
NEW YORK 17, N. Y.

F O R E W O R D

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JPRS: 3864

CSO: 4182-D

THE POLISH LONG-RANGE PLAN (1961-1975) AND FIVE-YEAR PLAN (1961-1965) FOR SCIENTIFIC RESEARCH IN AGRICULTURAL TECHNOLOGY

[Following is a translation of an article by Wincenty Zaremba in the Polish-language periodical Postepy nauk rolniczych (Advances in the Agricultural Sciences), Warsaw, Vol. VII, No. 1, January-February 1960, pages 3-20.]

(Based on materials prepared by working commissions in the Agricultural Machinery Section of the Committee for Machine Construction, PAN [Polska Akademia Nauk -- Polish Academy of Sciences].)

1. State of Agricultural Mechanization in Poland as Compared with Other Countries

The highest degree of mechanization and motorization in agriculture has been achieved by New Zealand, where there is one tractor for every 6 hectares of arable land. In Europe, the German Federal Republic (14 ha per tractor) has assumed first place ahead of Great Britain (16 ha) and is decisively ahead of other states in mechanizing work in agriculture. Only little Switzerland has the same coefficient as the German Federal Republic in motorization. The subsequent ranking is Norway and Holland with 19 ha, Austria with 21 ha, Belgium and Luxembourg with 26 ha, Sweden with 28 ha, Denmark, Ireland, etc.

In the United States there is an average of one tractor for every 42 hectares of arable land; in the German Democratic Republic, one for every 121 ha; in the USSR, one for every 125 ha. In Poland there is one tractor for every 258 hectares.

The rapid development of mechanization can be seen especially in industrial countries, where the movement of workers from rural areas into cities is closely connected with the development of motorization and the mechanization of agriculture.

On farms, mechanization also assists in obtaining larger production. Thanks to mechanization, farms can concentrate their efforts on the more labor-consuming and more profitable directions of production, intensive livestock raising, industrially-useful planting, vegetable growing, etc. These are directions of production which play an important role in progress in agricultural production, as well as in the supply of industry with raw materials. Correct mechanization of the rural areas is the only method which will make the vocation of farmer more interesting and capable of

being a part of the ambitions of thousands of young people the same way as nonagricultural vocations do. This is the way to liberate considerable reserves in human labor, directing them toward fulfilling the cultural needs of the population, and designating more time for rest.

2. Bases for the Plan of Scientific Work in the Field of Agricultural Technology

The tremendous development of mechanization in Polish agriculture planned for the coming 5 to 7 years places upon the machine industry, and especially upon the tractor and farm-machinery industry, very great tasks in starting the production of new types of tractors, farm machinery, and technical equipment, of which many types have not been used hitherto in Poland.

The long-range production plan in the so-called key industry of farm machines alone foresees by 1965 the establishment of the production of over 200 new types and kinds of agricultural tools, farm machines, and technical equipment for farms. The total value of the production of tractors and farm machines by this key industry will amount to over 23 billion zlotys in 1965. Together with the industry in the provinces, as well as the production of cooperating plants, it will amount to over 30 billion.

The benefits which our agriculture will obtain from the implementation of this tremendous group plan for the mechanization of agricultural work, without precedent not only in Polish history but also in the history of other countries, will require great technical progress in the field of producing technical equipment, as well as in the field of its appropriate exploitation by farmers.

The attainment of considerable technological progress requires, however, the support of foreign experimentation and research. These, however, frequently do not appropriately take into account practical application under our conditions. Thus we also require our own intensive scientific research in the field of organization and methods for the utilization of modern technical equipment. These investigations are indispensable, if Poland wants to take an active part in world technological progress and to introduce progressive agricultural technology.

The Extent of the Plans

The plans presented encompass scientific research in the field of the theory of tractors and agricultural machinery, because this field of investigation enters into the competence of the Agricultural Machinery Section, Committee for Machine Construction, PAN. It is necessary, however, to emphasize that many subjects in the field of theory are connected with subject matter from the field of mechanizing agricultural work. At times it is impossible to separate the

fields of the theory of farm machinery from the field of their utilization (e.g., certain problems concerning the mechanical treatment of the soil, the problem of drying farm crops, etc.).

Agricultural technology, embracing a tremendous and varied area of activity and hence disposing of a large supply of different tools, agricultural machines, and tractors and technical equipment, possesses specific characteristics that differentiate it from other fields of technology. For this reason, much scientific research also has a different, unique character.

Perhaps the first and most important characteristic of farm technology can be said to include the tremendous variation and changeability with which tools and farm machines come into contact. This variation and changeability -- take soil, for example -- to date have not been sufficiently investigated from the point of view of influence upon the development of crops. Neither has there been an explanation, for example, for the especially complex processes of separation in the case of certain agricultural products.

Another specific characteristic of farm technology in the field of certain tools for cultivation, as well as certain machines and technical equipment, is based upon the fact that the work of these technical media (and also the direction of theoretical research) must take into consideration the physiology of various cultivated plants or livestock. In other words, certain areas of agricultural technology, including scientific investigation, are closely connected with the life of plants and farm animals.

The third characteristic of many farm machines is the work done not only in the presence of varying types of opposition but also during movement in the field or meadow. This causes the manifestation of additional acceleration, that is, additional tensions in machinery which are difficult to foresee and designate by designers. On the other hand, in order to cut down the energy being expended through opposition to the machine's movement, machines should be constructed as lightly as possible.

Theoreticians and designers of tools, farm machines, and tractors should have enough comprehension in the field of the agrotechnical requirements concerning these machines or equipment in which they specialize. Agrotechnical requirements should, it is clear, be established by farmers -- users of the technical equipment. Since there exist, however, very many factors influencing the development of plants and a number of these factors and their influence on the development of plants cannot as yet be explained sufficiently by the natural sciences, the experts and scientists-farmers cannot always make their requirements more precise. Such a state of affairs at times makes more difficult a selection of the correct direction for research in the field of the theory of farm technology.

Due to the great changeability and differences in agricultural conditions, many technological processes and power relationships can not as yet be embraced by accurate analytical formulations. Under such conditions, researchers must limit themselves to a graphical presentation of how processes look and of changes in power. This method of looking at results from measurements indicates at least the tendencies of changes in processes with regard to the various changing parameters. Such a final effect of research work does not give the designers of farm machinery accurate patterns for computations, it is true, but it does allow them at least to obtain an idea as to what they may expect by changing this or that hypothesis.

Progress in the agricultural sciences poses ever new demands concerning farm technology, the practical solution of which frequently requires the conducting of scientific investigations. On the other hand, modern technology in agriculture poses certain requirements in relation to agrotechnology and indicates what agrotechnical or livestock research should be conducted (e.g., the raising of single-blade beet seeds for making possible accurate machine planting, the utilization of straw after the combine has cut the grain in order to fertilize the soil so that the use of the combine can be simplified and made cheaper, etc.).

The preparation of a plan for a period of several years or, even more so, for more than 10 years, for scientific activity concerning the technological fields, especially the field of agricultural technology, requires not only a good acquaintance with the present problems and attainments of world science but also accurate forecasts of future farm needs in the field of mechanization. Since these requirements are dependent upon new agrotechnical achievements, upon future economic conditions, and even upon social conditions in rural areas -- in brief, upon factors unknown to us at present -- it is necessary to become a prophet in order to work out without error the long-range plan for scientific activity. Hence the plans presented here do not claim and cannot have any claim to be without error. Nevertheless, they represent a certain signpost, but a signpost which is not rigid and thus can change if the experience and economic needs of the country require it.

State of Scientific Centers and Cadres

Currently there exist the following scientific research centers which are concerned with the problems of agricultural technology:

1. Institute for the Mechanization and Electrification of Agriculture, Warsaw, subordinate to the Ministry of Agriculture.
2. Institute for Agricultural Machinery, Poznan, subordinate to the Ministry for Heavy Industry.

3. Department for Agricultural Machinery, Tools, and Equipment attached to the Polytechnic Institute, Warsaw.

4. Department of Agricultural Mechanization at the Poznan Polytechnicum.

5. The Mechanization Department at the Main School for Agricultural Economy, Warsaw.

6. Six Departments for Mechanization at the Higher Agricultural Schools in Krakow, Lublin, Olsztyn, Poznan, Szczecin, and Wroclaw.

The work of the Institute for Agricultural Machines at Poznan is primarily of a practical nature, and research there is directed toward the solution of problems resulting from the acute needs of industry.

The departments for the most part belong to higher agricultural schools; thus it is difficult to speak about their exclusive devotion to studies of the theory of agricultural machinery, since a large part of the work will be devoted to applied problems.

Apart from this, the departments at higher agricultural schools and technical schools have limited possibilities for implementing their scientific research work because of the small personnel and the heavy load of didactic work, as well as the frequently insufficient space and weak funds. Under such circumstances, in order to broaden the field of research currently in process and to create the conditions for the implementation of a designated plan, it is necessary to insure the appropriate means for improving the laboratory base, i.e., for the construction of space as well as for the equipping of scientific research installations with measuring-research devices imported from abroad or produced in the country. In many instances this will pertain to unique apparatuses produced as single units on order.

Of the above-mentioned centers, the largest possibilities for implementing research work are available to the Institute for Mechanization and Electrification of Agriculture, because of the existing material base as well as a certain amount of experience in scientific work. Regarding the work of the Institute, there arises the necessity for calling into being a separate branch of "Fundamental Problems in Agricultural Technology," which would be free from emergency services to industry and agriculture, appropriately provided with personnel and equipment, and connected with the activity of other scientific centers. Without the establishment of such a unit, there can be no talk of any effective development in the organization of research in basic problems.

The number of scientific cadres working on the mechanization of agriculture is very limited, and the number of scientific cadres working on theoretical problems, as well as on conceptualization, in the field of agricultural technology is catastrophically small. The number of independent scientific workers (professors and lecturers) does not exceed six persons in the entire country, of whom only

two are professors. In its majority, this is a cadre which does not have many years of tradition, which has been almost nonexistent in Poland. There arises the necessity for making more accurate the developmental directions of the individual departments and helping them in specialization. Coordination and supervision over scientific research work on the part of the Agricultural Machinery Section, Committee for Machine Construction, PAN, can help a great deal in this area.

Such a small scientific cadre in the departments and in the Institute for Mechanization and Electrification of Agriculture cannot, of course, take care of the tasks resulting from the projected plans. Apart from the increase in the number of scientific cadres, the implementation of the tasks requires:

a. improvement in the living conditions of the scientific workers, at least so that they can devote their entire time to scientific work;

b. increasing the number of laboratory workers, so that one scientific worker can have approximately two laboratory assistants with appropriate qualifications (hence, also paid appropriately);

c. appropriate supply of laboratory equipment and measuring devices;

d. making possible more extensively than at present access to foreign literature;

e. enabling several months of foreign study at scientific institutes and other scientific centers abroad.

Cooperation with Foreign Countries

Among the socialist countries, the greatest achievements have been attained in the field of agricultural theory by these:

1. Institutes in the USSR: WIM, WISCHOM, NATI.
2. Institute for Agricultural Technology at Potsdam-Bornim (GDR).
3. MGJ at Budapest (Hungary).

In the capitalist states:

4. Experimental station for tractors at the University of Nebraska (USA).
5. Institute for Agricultural Technology at Silsoe (NIAE, England).
6. Institutes at Voelkenrode (GFR).
7. Experimental station for tractors and agricultural machines at the University of Ultine (Sweden).

3. Directions of Scientific Research During 1961-1975

I. Agricultural tractors. In countries with advanced technology it is possible, on the one hand, to ascertain a trend toward solving a number of problems in the field of technological progress as regards constructing tractors, e.g., the development of machines designated for specifically defined work or universal machines, as well as in the field of applying new types of engines, e.g., turbines or hydraulic engines. On the other hand, there exist a number of problems the solution of which will allow a fuller implementation of a tractor engine's power, hence problems from the area of modern tractor dynamics, representing in reality self-propelling chassis for agricultural implements and machines.

These problems, characterizing the direction of the world development in this field of technical knowledge, have not been worked out by us to date because of the reasons mentioned in the foregoing.

The necessity of solving a number of scientific problems in the field of tractors is especially brought to the fore against a background of agricultural needs and the planned increase in the annual production of tractors to 40,000 units in 1965 and 46,500 units in 1975 according to the long-range economic plan.

II. Tools working the soil. In Poland, as well as abroad, to date studies have been concentrated on the solution of concrete construction problems. In the USSR, USA, and in the German Federal Republic studies on basic problems in the construction of agricultural tools, especially active tools which influence decisively the effective exploitation of tractor power, are currently in the initial phase and have not as yet attained a high scientific level. A prompt beginning of work in Poland would enable us to integrate our work into this world technical progress. In this connection, there exists the necessity of making serious studies in the field of construction theory.

We are considerably behind in the field of construction problems and methods of design research, especially as far as equipment and measurement apparatus are concerned.

III. Machinery for sowing and planting. To date applied machines have not been used properly, and the quantity of seeds planted is many times higher than requirements because of the lack of precision in functioning, damage to the seeds, and misplacing them in the soil. This also refers to the spreading of different fertilizers, which is carried out simultaneously with sowing. Thus there is a need for a basic approach to the problems of theory in sowing by machines of various materials, greater savings, and better adjustment to the physiological requirements of cultivated plants.

IV. Apparatuses for protection of crops. The technology of protecting crops in Poland has not as yet passed the stage of simple spraying and dusting, which require large chemical means and water.

In connection with this, there appear to be very pertinent scientific investigations as regards the theory of bringing chemical means to the crops. Already now, there are great needs and doubtlessly many more will become apparent in the coming 15 years.

V. Machines for gathering hay, grain, and legumes. During the past few years, abroad and in Poland, considerable progress has been made in the field of designing machines for the gathering of hay and legumes. This progress is dictated above all by the necessity of decreasing as much as possible labor expenditure, shortening the natural time for drying hay, decreasing the risks of bad weather, cutting the losses of feed components, and, finally, decreasing the costs of gathering.

Among the machines for gathering grain, the main interest abroad has centered upon the development of the construction of a grain combine in the direction of increasing its efficiency technically, making more efficient the functioning of its individual components, increasing its universality, facilitating its servicing, decreasing its size and weight. In this connection, there arises the need to work out theoretically foundations for certain completely new types of equipment which would work on new principles.

VI. Drying. With our climatic conditions, the required conservation of various agricultural products, and primarily their drying, is of great economic significance. The state of conservation has been extremely poor to date, as has been the lack of understanding among farmers, which causes colossal losses. Thus, according to estimated computations, during intensive grain-combine work, losses caused by a lack of drying or wrong kind of drying amounted to 8 percent of the entire amount of harvested grain, which equals about one half of all the grain imported from abroad. This also pertains to the conservation of fodder.

The current multitude of types of technical equipment used in agricultural drying in Poland are in the vast majority anachronistic. The result is a need to introduce scientific work in the field of theory as regards drying different kinds of agricultural crops. The results of this work should contribute in a decisive manner to technological progress in the construction of new drying installations functioning on a new basis.

VII. Machines for harvesting root crops. This direction of research has as its aim the establishment of the foundations for the construction of such machines for harvesting as would appropriately implement with little manpower a very complex operation in harvesting root crops with as little damage as possible. The lack of precise hypotheses and basic research are the reasons why we still do not have good machines.

VIII. Transportation equipment. The problem of transportation equipment came to the fore in agriculture primarily because the share of transport work today attains 40 to 50 percent of the total labor expenditure in work connected with livestock raising.

The problem of transporting loose materials represents one of the more important areas for research work, as attested by the large number of scientific publications in this field abroad. The subject matter for investigation in this field should encompass research on the processes taking place in transportation by means of various devices, in order to establish the phenomena taking place and on this basis the best parameters for construction and exploitation.

IX. Machines and equipment for raising livestock. The methods and technical means used to date for the preparation of animal feed are not satisfactory. Due to this, the feed obtained leaves much to be desired, and the fodder is not providing full benefit for the animals. As a result, this causes serious losses in milk and weight attainment. Thus necessary are theoretical investigations in the field of preparing feed which would have as their aim the improvement of the products attained, as well as a decrease in labor.

X. Automatization of agricultural processes. Farm technology is being systematically complemented through excellent machines. However, from the point of view of automation, its level does not equal as yet the general level in other fields of technology.

In order to improve the means of mechanizing agriculture, it is necessary to exploit judiciously the achievements of general technology and in this manner make more efficient the functioning of farm machines and make easier work with them. In this connection, it is necessary to begin research aimed at introducing automatic elements into agricultural technology.

XI. Search for new materials for the production of machines, tools, and agricultural equipment. This direction of research has as its purpose limitation in applying deficit materials like brass, bronze, acid-resistant steel, etc., in the production of machines. It is also concerned with the problem of limiting the wear of working parts, especially those coming in contact with the soil.

The substitution of machine parts made of one material often does not lead to the goal. In many instances, new forms must be worked out. Parts that have been newly formulated must fulfill their tasks well functionally, be appropriately resistant, long-wearing, etc. Research on these problems has as its purpose the establishing of foundations on which industry can design and produce certain of these parts from substitute materials.

XII. Apparatus and research methods. Currently the planning of farm machines has little basis in science and is founded on traditions, subjective attitudes, or very troublesome experiments of long duration. A thorough acquaintance with and establishment of parameters for the areas in which farm machines work, as well as the processes taking place during various types of work, will make possible the correct planning of machines.

XIII. Electro-combustion aggregates for line traction. With contemporary methods of work in agriculture, the power means (tractor) moves in the field together with the working machines. Power is used thus for the work of the machine, as well as for the movement of the tractor in the field, which causes damage to the soil by pressing it and also consumes power for moving the tractor that is often equal to or even greater than the power consumption for the appropriate work of the machine.

Accurate research on line traction in which the power means would be immobilized and only the working machine or tool would move, indicates this would bring tremendous savings in power consumption in mobile farm work and would eliminate the damaging pressure against the soil by tractor wheels.

5. Problems in Scientific Research During 1961-1965

I. Farm Tractors

1. Establishment of the best type of engine and its parameters, taking into consideration their influence on the attributes of the tractor. There are different problems, e.g., the disposition of engines for cooling purposes, revolutions per minute and fuel consumption, automatic control of the engine, filtering processes, and, finally, the application of turbine engines.

2. Attainment of the optimum for attaching drive elements with a base. In this connection, the number of problems is especially large and includes the selection of drive elements and the establishment of the optimum parameters for them, ascertaining the influence on soil properties and conditions upon the coefficient of attachment, appropriate use of the tractor's weight and suspended tools, with which the problem of devices for lifting tools arises, which in itself is a separate problem.

3. Making services more efficient, which includes such problems as supporting and controlling mechanisms, controlling vibrations and noise, and the use of power steering.

TABLE 1

4. COMPILATION OF BASIC ELEMENTS IN THE LONG-RANGE PLAN FOR SCIENTIFIC RESEARCH 1961-1975

No.	Direction of scientific research	Scientific departments		Research centers				Departments	
		Current number	Increase	Current number	New means			Current number	New departments
					PAN	Schools	Ministries		
	2	3	4	5	6	7	8	9	10
1	Farm tractors	5	20	1				4	--
2	Tools for working soil	7	17	2	1	--	--	5	--
3	Sowing and planting machines	5	19	2	1	--	--	4	--
4	Apparatus for plant protection	4	8	2	--	--	--	--	*
5	Machines for harvesting hay, grain, and legumes	10	30	2	1	--	--	4	--
6	Drying activities	8	21	2	1	3	--	--	*
7	Machines for root-crop harvesting	5	12	2	1	--	--	1	--
8	Transportation equipment and means	12	20	2	1	--	--	3	--
9	Machines and equipment for raising livestock	8	30	2	1	3	--	3	2
10	Automation in farm work	--	10	--	1	--	--	--	*
11	Search for new materials in production of parts for machines, tools, and farm equipment	1	12	1	--	--	1	--	--
12	Apparatus and research methods (for accurate knowledge and definition of areas in which the machines, tools, and agricultural equipment work)	2	8	1	1	--	--	--	--
13	Electrocombustion aggregates for line traction	2	8	--	--	--	1	--	1
	Totals	69	215	--	--	--	--	--	--

* Specialization

TABLE 1 [continued]

No.	Necessary equipment 11	Nature of growth 12	Cooperation with foreign nations, centers 13	Required financial means in millions of zlotys: Staff expenses 14	Materials and power 15	Equipment 16	Investments in construction 17
1	5 brake devices	rapid	USSR, GFR, USA, Italy, England	7.5	0.5	5.0	4.0
2	apparatus for measuring	"	USSR, GDR, GFR, USA, England	6.4	1.5	4.0	0.5
3		"		7.1	0.5	5.2	0.2
4		"	USSR, GDR, GFR, USA	3.0	0.4	2.3	--
5		gradual	Czechoslovakia, GDR, USSR, USA, Hungary, England	11.3	0.5	6.0	1.5
6		rapid	USSR, USA, Holland, England, GFR	7.9	0.55	2.4	4.5
7		"	Czechoslovakia, GDR, Sweden, GFR	4.5	0.5	2.0	--
8		uniform	GDR, Czechoslovakia, England, GFR	7.5	1.0	5.5	--
9		rapid	Denmark, Sweden, GDR, France	11.3	0.5	4.0	8.0
10		gradual	USSR, USA, England	3.8	0.2	2.0	--
11		rapid	Czechoslovakia, GDR, USSR	4.5	2.8	0.5	--
12		gradual	USSR, USA, GDR, England, GFR	3.0	0.2	2.5	1.0
13		"	Austria, Switzerland, Czechoslovakia, GFR	3.0	0.4	2.0	--
			Totals	80.8	9.55	43.4	19.7

II. Tools Working the Soil

1. Research on the contact between masses of earth and work tools, their deformation under the influence of manifested tensions Studies on adapting soil removers to different work conditions.

2. Research on the influence of vibrations and those provoked by farm tools, and the results.

3. Studies on the work of active tools. Working out theories for rational forms as applied to the working parts of rotating plows, milling machines, and other agricultural tools. Points 2 and 3 have as their aim the construction of lighter, more efficient, and better adapted tractors after eliminating the classic plow, which, as a passive tool, requires more attachments and greater weight in a tractor.

III. Machines for Sowing and Planting

1. Studies of equipment for precision in the sowing of one type of seed or cluster-type sowing, as well as studies of equipment for combined sowing. The construction of combined sowing machines permits an increase in crops as a result of the better use of fertilizer by the plants, as well as a saving of fertilizers. Currently this type of sowing machine is being produced at too low a rate.

2. Studies on the design of rapidly-moving machines for planting cabbage plants. It is imperative that we work out a concept for the automatization of the mechanisms which drop the plants, since the currently-used machines with manual servicing are uneconomical and require considerable work, the quality of which is not always good.

3. Research on the kinematics of equipment for the mechanized growing of sugar beets. Introduction of precision sowing in connection with mechanized cutting of the beets will allow a 40 percent decrease in labor. There is a lack, however, of foundations for the construction of such efficient equipment, and those in existence show many deficiencies.

IV. Apparatus for Crop Protection

1. Research on improvement of the results and quality achieved with spraying is one of the means which should lead to an increase in this technology. Abroad, various quite sensational methods are being investigated, among others, spraying with electrified liquids, etc.

2. Having been applied for some time now, spraying and dusting from aircraft has not as yet been economically justified. This condition has changed considerably now that many countries have been applying oil treatments from the air. These treatments are many times cheaper than those applied to date and effectively compete with ground machinery. In Poland, the oil-spraying technology is still in its infancy.

V. Machines for Collecting Hay, Grain, and Legumes

In this connection, research has isolated eight problems which have been compiled in Table 2. The formulation of the individual problems is clear and lucidly indicates the solution pertaining to each problem. Only problem No. 8 in Table 2 may require additional explanation. It is called the "theory of processes for separating masses of different stalk materials." Here we are concerned with the importance of mechanizing the unloading from trailers of straw masses loosely loaded, pressed, or cut into chaff and their loading into barns, attics, heaps, etc. The current level of mechanization in loading and unloading from trailers, as well as transfer to storage, requires in hay collection work a labor expenditure which equals 40 percent of the total labor expended in the entire process. The solution to this problem requires theoretical foundations for the processes of dividing the mass of different stalk materials into parts, taking into consideration the influence of fundamental parameters which characterize the material.

VI. Drying

1. Research on methods for the slow drying of grain, mainly of the combine type, in silos or other aired installations by means of a stream of unheated or slightly heated air.

Investigation aimed at improving the technology of drying seeds in column-type dryers. Research on the fluidization-type method of drying seeds.

2. Research aimed at improving equipment for the artificial drying of legumes. Investigation in the field of the automation of measurements and control of the drying process. Investigation of the processes used in pneumatic drying. Research on the application of infrared rays. Research on methods of storing dried materials.

3. Investigation of the technology of drying corn to be used as seed. Research on the processes taking place in dryers. Here emphasized is the striving toward the construction of huge "seed factories" in which the entire technological process will take place, from drying to calibrating and storage.

4. Poland could be the producer of a large quantity of medicinal herbs. Even now, with the primitive method of drying, which represents the basic technical procedure in the herb industry, we export a number of herbs. To date we have not worked out the theoretical bases which would produce rational methods and new conceptualizations for drying installations. Currently, in Poland 42 large but antiquated and uneconomical dryers for herbs are in operation, the production of which covers only about 10 percent of needs.

TABLE 2

C. COMPILATION OF BASIC ELEMENTS IN THE FIVE-YEAR PLAN FOR SCIENTIFIC RESEARCH 1961-1965

No.	Research direction	Problem	Increase in scientific cadres	Research centers	
				conducting	collaborating
1	2	3	4	5	6
I	Farm tractors	1. Greater efficiency of engine	8	IMER	Politechn. Warszawa i Poznan
		2. Improving transfer of motor power and better exploitation		IMER i SGGW	IMR
		3. Improve work conditions and tractor servicing		CIOP	IMER
II	Tools working the soil	1. Precision and combined sowing	7	IMER	WSR Lublin Politechn. Poznan
		2. Rapid-moving planters		WSR Lublin	IMER
		3. Kinematics of beet-cultivation machines		IMER	WSR Olsztyn
III	Sowing and planting machines	1. Improving methods for bringing chemicals to plants	9	IMER	Politechn. Poznan
		2. Air equipment to combat noxious insects and plant diseases		IMER	
		3. Kinematics of equipment for beet cultivation		IMER	

Explanation of abbreviations occurring in columns 5 and 6:
IMER -- Instytut Mechanizacji i Elektryfikacji Rolnictwa (Institute for Mechanization and Electrification of Agriculture); SGGW -- Szkola Glowna Gospodarstwa Wiejskiego (Main School for Rural Economy); CIOP -- Centralny Instytut Ochrony Pracy (Central Institute for Labor Protection); (continued at bottom of page 16)

TABLE 2
(continuation of Nos. I-III)

	Required equipment	Cooperating foreign countries	Anticipated deadline: Completion	Anticipated deadline: Introduction	Anticipated financial means in millions of zlotys: personnel	materials and power	equipment	construction investments
	7	8	9	10	11	12	13	14
1.	Two electrical braking devices	USSR, GFR, USA	1965	After solution of problem	1.6	0.2	2.0	1.5
2.		Czechoslovakia, Italy, England	1961-1965					
3.		Czechoslovakia						
1.	Special apparatus	USSR, GFR	1964		1.4	0.6	1.5	0.2
2.	Vibrograph-analyzer	USSR, GFR	1962					
3.		GFR, USSR, Italy	1965					
1.	Soil canal models	Czechoslovakia, GDR, France	1964		1.8	0.2	2.0	--
2.	"							
3.	"							

WSR -- Wyzsza Szkola Rolnicza (Higher Agricultural School);
Pol. Warsz. -- Politechnika Warszawska (Warsaw Polytechnicum);
IMR -- Instytut Maszyn Rolniczych (Institute of Agricultural Machinery);
IHAR -- Instytut Hodowli i Aklimatyzacji Roslin (Institute of Plant Cultivation and Acclimatization);
Zarzad Przemyslu Zielarskiego -- Board for Herb Industry.

TABLE 2 (continued)

No.	Research direction	Problem	Increase in scientific cadres	Research centers conducting	Research centers collaborating
1	2	3	4	5	6
IV.	Apparatus for crop protection	1. Improvement of methods for bringing chemicals to plants	4	IMFR	IMR, IOR
		2. Aerial equipment to combat noxious insects and plant diseases		IMER	
V	Machines to gather hay, grain, legumes	1. Theory of new methods for separation of grains from ears and separation of grain from mass of straw	12	IMER	IMR
		2. Theory of sunflower disc cutting and separation of seeds		IMER	IMR
		3. Theory of splitting corn ears to hasten drying		IMER	IMR
		4. Theory of new methods for cutting plants on the stump		IMER	
		5. Crushing of legumes to hasten drying (theory of functioning of crushing rollers)		IMER	WSR Olsztyn
		6. Pressing of legumes		IMER	IMR
		7. Making briquets from hay by various technical means		IMER	IMR
		8. Theory of processes for separation of masses from various stalk materials		IMER	

TABLE 2
(continuation of Nos. IV-V)

	Required equipment	Cooperating foreign countries	Anticipated deadline: Completion	Anticipated deadline: Introduction	Anticipated financial means in millions of zlotys: personnel	materials and power	equipment	construction investments
	7	8	9	10	11	12	13	14
1.	Special apparatus	USSR, USA, GFR	1965		0.8	0.2	1.3	--
2.	[blank from columns 7-14]							
1.	Special measurement stand and models		1964	After solution of problem	2.4	0.2	2.5	0.7
2.	"	USSR	1962					
3.	"	USSR, Hungary, Rumania	1962					
4.	"	England	1961					
5.	"	USA, GFR	1961					
6.	"		1962					
7.	"		1963					
8.	"	USSR, Czechoslovakia	1963					

TABLE 2 (continued)

No.	Research direction	Problem	Increase in scientific cadres	Research centers	
				conducting	collaborating
1	2	3	4	5	6
VI	Drying	1. Modern methods for drying grain seeds, vegetables, etc. (fluidization drying, rays, vacuum)	9	IMER	IMR
		2. Pneumatic processes in drying legumes		IMER	Pol. Warsz.
		3. Drying of corn stalks		IMER	Pol. Warsz. IHAR Zarzad
		4. Drying of medicinal plants		IMER	Przemyslu Zielarsk.
VII	Machines for root crop harvesting	1. Influence of vibrations in working parts of digging machines on soil separation	5	WSR Lublin, Poznan	IMER, IMR
		2. Process of cropping beets		IMER	
		3. Combined process for root-crop harvesting		IMER	IMR
VIII	Transportation equipment and means	1. Theory of functioning by pneumatic, caterpillar, and gripping carriers	8	Pol. Warsz. IMER	IMR
		2. Research on phenomena occurring in floating of seed		Pol. Warsz.	IMER
		3. Exploitation of fluid drive in the transportation of seed		Pol. Warsz.	IMER
		4. Research in theory and mechanized functioning of equipment for elimination of manure from cow sheds		IMER	Politechnika Warszawska

TABLE 2
(continuation of Nos. VI-VIII)

	Required equipment	Cooperating foreign countries	Anticipated deadline		Anticipated financial means in millions of zlotys			
			Completion	Introduction	personnel	materials and power	equipment	construction investments
	7	8	9	10	11	12	13	14
1.	Construction of 3-5 measurement stands	USSR, GFR	1965		1.8	0.25	1.0	2.0
2.	Construction of a measurement stand	Holland, USSR, England	1964					
3.	Semi-technical dryer	USSR, USA	1963					
4.	Construction of two new positions	--	--					
1.	Special measuring apparatus		1962	After solution of problem	1.0	0.2	1.0	--
2.		GDR, GFR	1962					
3.		USSR, GFR, Czechoslovakia	1964					
1.	Special research post	GDR, Czechoslovakia	1962		1.6	0.4	2.5	--
2.	"		1962					
3.	"	GDR, Czechoslovakia, Sweden	1964					
4.	Model equipment		1963					

TABLE 2 (continued)

No.	Research direction	Problem	Increase in scientific cadres	Research centers conducting	Research centers collaborating
1	2	3	4	5	6
IX	Machines and equipment for raising livestock	1. Theory of action by elements supplying stalk materials into chaffing machines	12	IMR, WSR Poznan	IMER
		2. Mechanical process for mincing feed		IMR	Pol. Warsz.
		3. Research on behavior of loose feed materials and making briquets out of them		Politechn, Poznan	WSR Poznan
		4. Processes occurring when mixing loose feeds with cake feeds		IMER	Instytut Zootechn.
		5. Structure of sour layer in silo container and conduct of fermentation		IMER	
		6. Work elements in equipment for pressing, unloading, and heating silos		IMER	
		7. Functioning of machines and equipment for milking and initial transformation of milk		IMER	IMR, SGGW, Inst. Zootechniki
X	Automation of farm processes	1. Plans for wagon with brake and automatic steering	3	IMER	
XI	Search for new materials in production of parts for machines and farm equipment	1. Selection of materials for parts of machines working the soil	4	IMER	
		2. Selection of materials for working elements in apparatus protecting plants with special regard for substitute derivatives		IMER	IMR, Instytut Chemii

TABLE 2
(continuation of Nos. I - XI)

	Required equipment	Cooperating foreign countries	Anticipated deadline		Anticipated financial means in millions of zlotys			
			Completion	Introduction	personnel	materials and power	equipment	construction investments
	7	8	9	10	11	12	13	14
1.	Special research post		1964		2.4	0.2	2.0	3.0
2.	"		1963	After solution of problem				
3.	"		1963					
4.	"		1964					
5.	Model silo container	USA, England	1963					
6.			1965					
7.	Model equipment		1965					
..		USSR	1963		0.6	0.1	0.8	
1.	Laboratory for testing resistance	USSR, GFR			0.8	0.8	0.2	
2.			1964					

TABLE 2 (continued)

No.	Research direction	Problem	Increase in scientific cadres	Research centers conducting	Research centers collaborating
1	2	3	4	5	6
III.	Apparatus and research methods (for detailed knowledge and definition of areas in which machines, tools, and farm equipment are working)	1. Apparatus for a laboratory of mechanics in a soil center	3	WSR Lublin	IMER
		2. Equipment for investigation of subterranean tension on parts of agricultural machines		IMER	
		3. Plans for rapid methods of comparing in order to define the quality of spattering		IMER	IMR, IOR
		Totals	84	--	--

[continuation of above]

No.	Required equipment	Cooperating foreign countries	Anticipated deadline: Completion	Anticipated deadline: Introduction	Anticipated financial means in millions of zlotys: personnel	materials and power	equipment	construction investments
1	7	8	9	10	11	12	13	14
1.		GFR, USA	1963	After solution of problem	0.6	0.1	0.3	
2.		USSR, GFR	1963					
3.			1965					
Totals		--	--		16.8	3.45	17.8	7.0

VII. Machines for Root Crop Harvesting

1. The influence of the vibrations of working parts of digging machines upon the quality of separating plants from the soil, as well as research on other methods for separating the soil from the roots of beets and potatoes. The working methods used to date in digging out these crops do not guarantee a good separation of the soil, and under certain conditions at times cause excess damage to potatoes, which causes serious losses in storage, increased costs of transportation and labor in collecting the potatoes that have been dug out and in cleaning them.

2. Research on the process of cropping beets. The tools used for this do not secure a good quality of cut and cleanliness of the leaves, which causes a considerable loss in sugar, as well as an increase in work for corrections, and, finally, a worsening of the value of the leaves for feed and storage.

3. Studies of the process for the combined harvesting of root crops is based on point 1. Research on the technology of the combined harvesting of root crops surpasses the possibilities of industrial laboratories because of their general nature, which requires the working out of theoretical ideas embraced by the plan indicated for 1961-1975. It is necessary to devise certain general concepts required in the working out of detailed projects.

VIII. Equipment and Means of Transportation

Under the direction of research specified in Table 2, four problems appear which have been formulated and should be clear. Perhaps Problem 3 requires further elucidation. It is called "Exploitation of fluid drive in the transportation of seed."

The advantages of fluid-drive equipment in transportation is its simplicity of construction, noiseless operation, and lack of mobile mechanical parts. In comparison with pneumatic transportation, fluid-drive transport requires much less rapidity in the flow of air into the transportation equipment. Due to the stiffness of the fluid phase, the dimensions of the carrier can be smaller than with pneumatic transport.

In view of the expressed advantages of fluid-drive transport, it should find wide application in practice. Research work to date in this field embraces only a part of the problems, and there is a lack of work concerning the correctness and appropriateness of fluid-drive transportation. Also, a number of phenomena taking place in fluid-drive transport, e.g., the problem of resistance, have as yet not been explained. Planned are investigations of a basic nature which will have application not only in connection with farm machines but also in other fields of technology.

IX. Machines and Equipment for Raising Livestock

Under this direction of research we have established seven categories of problems in the table. Their formulation appears to be obvious. Closer elucidation may be required by Problem 5, entitled "The structure of the sour layer in the silo container and the fermentation processes."

In designing machines and equipment for loading and unloading silo containers, the designer meets with a number of unexplained problems which appear unessential but which in reality have a decisive influence as regards the correct construction of these machines, taking into consideration requirements concerning the use of containers, the technology of preparing mash and feed for animals, and economy. These problems refer above all to the structure of the sour layer in the container, the process of fermentation, temperatures and their relationship to the degree of fragmentization, pressing, the size of free spaces, etc. The results of this research will permit the establishment of the most profitable construction and exploitation parameters for the mentioned machines.

X. Automatization in Agricultural Processes

Here we anticipate only one problem, actually a subject concerned with the designing of a wagon with brakes (required in the investigation of tractors) and automatic steering. Automatization is certainly a future direction for research. However, during the 5 years ending in 1965, we have a number of simple and more obvious problems to solve which leaves automatization for future years.

XI. The Search for New Materials in the Production of Parts for Machines, Tools, and Agricultural Equipment

1. The problem of selection of materials for the parts of machinery, especially:
   a. parts working the soil or affected by it;
   b. parts affecting the quality of the product being sown or gathered by the machine. There exists a number of technological problems which are specific to farm technology, e.g., the problem of wear in the case of parts coming into contact with the soil, the selection of materials for parts from the point of view of damage to seeds, etc.

2. For the construction of machines serving to protect plants, a large amount of deficit material is used. However, we already know of materials as substitutes which in all probability could be used instead of deficit materials. But due to their synthetic character, this problem extends beyond the possibilities of industrial research.

XII. Apparatus and Research Methods for Accurate Knowledge and Definition of the Areas in Which Machines, Tools, and Agricultural Machinery Operate

1. The designing of apparatus for the mechanical laboratories of soil centers. Equipment for research on the deformations and resistance of soils under the influence of dynamic deformations. Commencement of experiments and, based upon these, theoretical work.

2. Designing of equipment for research on the subterranean tension against the parts of farm machines, and especially investigation of the pressures manifesting themselves on the surface.

3. At the present level of technology, there appears the possibility of working out a quick method for comparing and designating the quality of splattering. The scientists who are working on these problems have already agreed upon many points. The time has come when it is possible to start work, discussion, and testing as regards certain research methods which will satisfy at least the most important postulates of the researchers.

7. Over-all Compilation of Financial Means

a. For the plan 1961-1975

	Anticipated financial means in millions of zlotys				
	staff expenses	materials and power	equipment	construction investments	totals
Scientific research in long-range plan	80.8	9.55	43.4	19.7	153.45

b. For the plan 1961-1965

	Anticipated financial means in millions of zlotys				
	staff expenses	materials and power	equipment	construction investments	totals
Scientific research in five-year plan	16.8	3.45	17.8	7.7	45.78

8. Conclusions

The implementation of the plan requires not only appropriate funds for the construction and equipment of scientific centers but also a sufficiently large and skilled scientific cadre. The training of the lacking scientific cadres, however, is possible only with a simultaneous assurance that the members will have such living conditions as will permit them to devote themselves completely to the solution of scientific problems. Until this happens, we should not be under any illusions as to the development of science.

The group of engineering sciences which is looking into the construction of farm machinery represents a group of sciences, among which are those engaged in designing problems, which are quite backward in comparison with other countries as well as in relation to the level of knowledge in other fields of the engineering sciences. The construction of farm machinery is extremely important to the national economy, because supplying the country with machinery, tools, and agricultural equipment places before the farm-machinery industry a task that is one of the leading tasks in Poland.

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